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of the modification of the species, so truly do all changes register themselves thereon," and it seems to me that in the brains of so-called "mimicing" species of insects, we might, if we could but understand the full significance of brain cells, read therein the records of the development of a dim, obscure consciousness, a volition and an intelligence that has kept pace with the requirements of these organisms, in protecting their lives and perpetuating their race. Man himself comes into the world, little less than a mere automaton, but with an inherited basis for future development of an individual consciousness. He begins his education with the alphabet, but does not transmit even a knowledge of this alphabet to his offspring, who must begin precisely where he himself began. But there has descended to his children, that which will enable them to master the alphabet with more aptitude and less difficulty. Now, if we descend the line of animal life, until we reach these insects whose movements go far toward perfecting the protection afforded by their form, color and coloration, may we not expect to find the foundation for a "species consciousness" that will enable the possessors to protect their lives from enemies of long standing and gradually, though, perhaps very slowly, adapt themselves to shunning the attacks of more recent foes? Or, to put the question in other words, with a protective appearance, will there not go either a consciousness of that appearance, or an inherited foundation for such a consciousness, that will the better enable an insect to apply its protective inheritance, and in the use of all of these, as a means of perpetuating its kind, follow strictly in the line of all other animal life?

NOTES ON THE TRANSFORMATIONS OF THE HIGHER HYMENOPTERA. II.

BY A. S. PACKARD.

Polistes (probably **P. canadensis** Linn.).

Larva.—It differs generically from *Vespa* in its head being about twice as large; the body is much shorter, a third shorter than in *Vespa*, and more ovoid; the end sharper, the body narrowing rapidly towards the tip, which is more pointed than usual; towards the head it tapers rapidly, the prothoracic segment being small in proportion to the head. The lateral ridge of the body is but slightly prominent. The body is not entirely cylindrical, but very convex above, and flattened beneath. The last sternite is twice as broad as long; the sides of the anal opening

are more exerted and prominent, the last tergite being much more produced than in *Vespa*. The nervous system is nearly the same in the middle of the body, but owing to the shorter segments the ganglia are nearer together, and each ganglion is opposite each suture; the size of the ganglia and of the cords are the same, but the ganglia appear to be a little farther separated than in *Vespa*, in the specimens examined.

The head is very large, round, short and broad, full, convex above. The eye-slits are long, narrow, oblique and prominent. The antennal tubercles are flat, depressed, large and conspicuous, and are placed on each side of the clypeus and in a line with the anterior or lower end of the eyes. The clypeus is large, very regularly equilaterally triangular, the apex or posterior portion separated by a slight suture from the anterior and much larger portion; the front edge is straight and aligned with the squarely docked front edge of the side of the head. Labrum very broad and short, nearly as broad as the clypeus is long; the front edge is straight, the sides well rounded; rounded, swollen, full and very prominent at the end. Mandibles broad, triangular, very acutely bidentate, much shorter and broader at base than in the Apidæ, very convex on the outer side. Maxillæ large, full, swollen, with two small corneous tubercles on the interior next the mouth. Very full and bulging externally. Labium well separated from the mentum by a distinct suture, with two terminal tubercles. Mentum broad, low, triangular, not quite reaching to the outer side of the maxillæ, but nearly as broad as the head.

It differs from the larva of *Vespa* in having the antennal tubercle a little more approximate, the clypeus more regularly triangular and more distinct, while the labrum is very much larger and excessively swollen. The mandibles are very different from those of *Vespa*, being bidentate, very acute, broad at base, triangular, while in *Vespa* they are tridentate, oblong, and as wide at the tip as at the base, the teeth being rather equal and blunt, while the mentum is not prominent. The entire head is freer from the body in *Polistes*, and harder, more corneous than in *Vespa*.

Both *Polistes* and *Vespa* larvæ differ from those of *Bombus* and Apidæ in general in having the clypeus and mouth-parts larger; by the antennal tubercles being more distinct, by the presence of the eye-slit, by the larger mandibles and maxillæ, while the entire head is larger in proportion to the rest of the body, and the surface of the segments are smooth. The end of the body is more acute, and the lateral ridge less marked. (In the larva of *Pompilus*, the segments are more thickened

than in *Megachile*.) The sides of the epicranium at the insertion of the jaws in *Vespa* do not bulge out, and become squarely truncated as in *Polistes*.

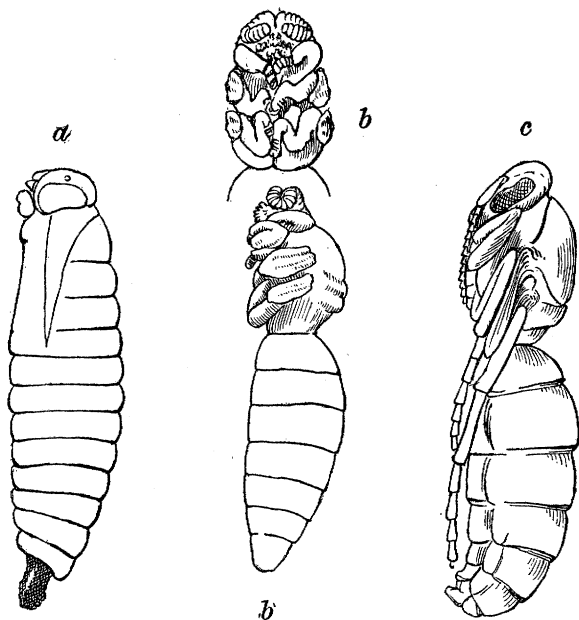


Fig. 6. *Polistes*, a, larva beginning to change to pupa; b, semipupa; b', ventral view of head and thorax; c, pupa, $\times 3$, (Emerton del.)

Pupa.—Compared with that of *Vespa maculata* the body is much longer and slenderer and the tubercle on the head is not near so large and prominent. The clypeus is longer and fuller; the labrum is small. The antennæ have the joints half as long, and the appendage, as a whole, is still less bent than in *Vespa*, and much shorter than in *Vespa*, not reaching to the tip of the anterior legs. The trochanters are very much larger than in *Vespa* and at least twice as long. The maxillæ are much shorter than in *Vespa*, the lingua not so deeply bifid. The legs are much longer than in *Vespa* and the wings do not reach so near the tibial spurs as in *Vespa*, while the hind legs nearly reach to the tip of the abdomen. Seen sideways, the legs and wings, especially, are much more oblique and parallel to the longer axis of the body than in *Vespa*. The thorax and long narrow subpedicellate abdomen are much as in the imago. The ovipositor is still exerted, while the last tergite is greatly

expanded, forming an irregularly hexagonal expansion, the end of which is broad and square, with the edge excavated.

Vespa (probably **V. arenaria** *Fabr.*).

Larva.—The head is about as long as broad, the vertex very slightly depressed in the mesial line. Eyes well marked by a long narrow testaceous line. Antennæ rather remote from the sides of the clypeus, when compared with those of *Polistes*; the round flattened antennal area, situated within an ovate much larger area, is obsolete in *Polistes*. The clypeus is much longer and narrower than in *Polistes*, extending farther back towards the vertex; the posterior portion not being so clearly divided from the anterior part as in *Polistes*. It is a quarter longer than wide, and it differs very much from *Polistes* by its front edge contracting and narrowing towards the labrum, where in *Polistes* it rather spreads, so that the labrum is much narrower, being less swollen, and shows a tendency to become bilobate. Mandibles stout, thick, oblong, bidentate, the teeth small, cylindrical, not nearly so sharp as usual. The maxillæ are 2-tuberculate, swollen externally. The labrum is distinct from the mentum, with two terminal tubercles, and a terminal testaceous line, probably the lingua.

The body is long, cylindrical, not curved on itself so much as in *Polistes* owing to its posture in the broad cell, which is longer and narrower than that of *Polistes*. Posteriorly each segment is somewhat thickened, as are the pleural ridges. The end of the abdomen is rather blank, the last sternite large and transverse, while the tergite is considerably smaller than in *Polistes*. The elements of the ovipositor are distinct, two rather remote tubercles visible on the 8th abdominal segment, and 4 arranged in a semicircle on the 9th, the two inner ones much larger than the minute outer pair. Above, owing to the thinness of the pellicle along the median line of the body, the dorsal vessel can be distinctly seen in the alcoholic specimens; each section of the vessel dilating probably near the posterior edge of each segment where the valves are probably situated and dilating not angularly so to speak from the insertion of the succeeding section.

Halictus parallelus *Say* and **H. ligatus** *Say*.

Larva.—Body very slender, cylindrical, quite different from the broad flattened body of *Andrena*; it is rather obtuse behind, but in front tapering slowly towards the head, which is of moderate size, and of the width of the prothoracic segment. The thoracic segments are a little tuberculated on each side; they are much more convex than the

abdominal segments which are nearly smooth and very round. The specimen described was not fully grown and was found by Mr. J. H. Emerton, August 13, with eggs of the second brood.

When the larva has voided all its excrement the tubercles over the whole body become very prominent, extending from low down on the side of the body, forming high, regular, very prominent transverse ridges, which beneath the abdomen are more prominent than on the inside of the thorax. Length, .40 inch.

In examining the larvæ of *H. parallelus* and *H. ligatus* the head only differs, so far as one can tell, by the sides of one species bulging out; in the mandibles of *H. ligatus* being longer and slenderer, and the notch below being longer and ending in a distinct seta. The head in the two species is of about the same size; the clypeus is of the same shape, the head above being a little more divided in *H. parallelus* than in *H. ligatus*. The entire larva of *H. ligatus* is much longer and slenderer than that of *H. parallelus*, and the thickened tuberculous portion of the segments inclined to be a little more prominent. These differences are sufficient to produce changes in form, rendering the identification of the larva easy, but the best specific characters are the differences in size and slenderness of form. The larvæ being just in the period approaching the semi-pupa stage, the head is protruded and the segments more or less elongated, as the parts of the pupa growing beneath press out the larval skin in various directions. The ovipositor can not be detected beneath the thin larval skin.

This larva (the following description applies to it when in the early semi-pupa stage, and there are no hairs yet developed) differs from that of *Andrena vicina* in being longer and slenderer in proportion. The antennæ are shorter, stouter and more clavate. The mandibles in this stage are not corneous. The maxillæ are shorter, the lingua much longer than the tips of both pairs of palpi, which are of the same length as in *Andrena*. The two tubercles behind the ocelli are unusually prominent. Of the three ocelli, which are arranged at points in an equilateral triangle, afterwards becoming a very slight curved line, the middle one in front is not raised.

In front of the ocelli, arranged transversely in a slight curved line, are four low, flat tubercles which resemble the ocelli; these disappear when the pupa becomes mature. The head and front, including the clypeus and labrum, are as in *Andrena*, but the supra-clypeal region in the specimen before me is better marked. The legs are a very little slenderer, and the hind tarsi do not reach nearly to the tip, but only half way, as the abdomen is much less elongated than in *Andrena*.

The thorax is very convex, there are two high prominent tubercles on the scutellum, which are higher and longer than in *Andrena*, also two smaller ones on the meta-scutellum (none on the port-scutellum). The propodeum is more like an abdominal segment than a thoracic one; it is broad and square-cornered, twice as broad as long, not yet separated from the abdomen. The latter is now one-half larger than the head and thorax. The segments posteriorly are very convex, and the edges very distinctly, thickly and finely dentate; the end or terminal segment of the abdomen is long and slender.

The presence of the four deciduous semi-pupal tubercles on the head, which in this stage are so large and distinct, and which are arranged in a transverse line just in front of the ocelli, is interesting and deserves further investigation, as their use is unknown. The fact that all these tubercles disappear afterwards is of additional interest, also the circumstance that they do not exist at all in the corresponding stages of *Apis* and of *Bombus* is perhaps a characteristic of that sub-family of Apidæ (*Andrenetæ*) of which *Halictus* is a member.

The pair of tubercles on the meso-scutellum and meta-scutellum are also of corresponding interest. They are scarcely homologous in position with those of *Oxybelus*, except those on the meta-scutellum. The serrate, very convex abdominal segments are noteworthy, as being a "low" feature. Also noticeable are the great differences between the two high posterior tubercles on the sides of which are situated the two posterior ocelli, so different from the anterior sunken ocellus.

***Andrena vicina* Smith.**

Larva.—In *Andrena vicina* the larva is not only much larger, stouter and thicker than that of *Halictus* (*H. parallelus* and *ligatus*), and not so long in proportion, but the thickened tuberculous portion of the segments is broader, and not so sharply ridged. The two tubercles on the head are more prominent. The clypeus is wider and squarer, and the entire clypeal region broader; the mandibles are stouter and blunter, as are the maxillæ; the best characters are the stouter, more truncate mandibles, and the more raised tubercles on the vertex.

Head with the vertex rather deeply impressed by the median line; on each side is a high, prominent, acute tubercle. The lateral region on each side of the depressed median portion bulging, convex. This median region is divided into two slightly convex pieces. The clypeus is divided into an anterior and a posterior portion. The labrum is nearly square, quite distinct from the clypeus; the edge is square, the sides narrowing very slightly towards the front edge. On each side of the front edge of

the clypeus is a dark, corneous, minute, stout, acute spine. (The use of this process is unknown; it is not present in the larva of *Sphex*, and is an interesting larval structure.) The mandibles are long, narrow, incurved, the tip very acute and rather long. The maxillæ are cylindrical, stout, short and thick, obtuse, ending in a corneous, black, low, obtuse tip. The labium is short, divided a little at the end, and in the middle into two short, obtuse tubercles.

Compared with the larva of *Bombus* the vertex is not so rounded and smooth, while the lateral eye-pieces are remote and more bulging in front, leaving a broad, depressed mesial interspace; the distinction so marked in *Bombus* between the clypeus and labrum is in *Andrena* almost annulled, the labrum in *Andrena* being at first easily mistaken for an anterior portion of the clypeus, until after comparison has been made; its edge differs from that of *Bombus* and most other hymenopterous larvæ in being square, entire and much longer, while the trophi, *i. e.*, the maxillæ and labium, are in *Andrena* a little shorter, less produced beyond the mandibles and labrum. In *Andrena* and *Halictus* the segments are much more convex and angular, more tuberculous, while the last abdominal segment is broader, more transverse than in *Bombus*, where it is orbicular.

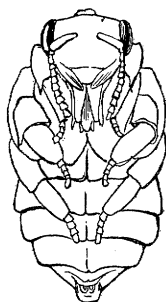


Fig. 7. *Andrena vicina*, pupa, enlarged nearly three times. (Emerton del.)

Nomada (probably *imbricata* Smith).

Larvæ.—The head is much smaller in proportion to the rest of the body than in *Andrena*, smoother and rounder, somewhat flattened, seen from in front somewhat square, with the angles rounded off; the eye-pieces not full convex as usual, but continuous with the middle of the front, which is not depressed mesially. Two black chitinous tubercles situated rather far apart on each side of the epicranium in a line with the insertion of the mandibles, being much farther apart than the sides

of the clypeus, which is short and narrow, projecting from the epicranium and shorter than the labrum. The latter is squarish, convex and rounded at the end, which is thickened, with the edge entire, and provided with four chitinous acute tubercles, two on the edge and two behind. There is a deep depression or pit between the labrum and the insertion of the mandibles. The latter are short, very stout, thick, conical, suddenly ending in an acute mucronate point or spine; they are short, situated far apart, and in my alcoholic specimen do not meet, only reaching to the sides of the labrum. Maxillæ unusually short, low, obtuse, thick, terminating in two very minute corneous, low, obtuse tubercles. Labium stout, short, thick, obtuse. Body long and slender, the segments very regularly convex, scarcely thickened, more so in the middle of the body than in the prothoracic segment, where it is most marked in *Andrena*; the lateral region distinct, the smaller portions less marked than in the higher genera, an important distinction, especially observable in the lower genera of fossorial Hymenoptera, such as *Sphex*, where there is scarcely any difference in shape between the prothoracic and the abdominal segments. Beneath, the segments are smooth, regularly convex, not thickened. The body is straightened out more than usual, tapers unusually fast towards the end of the abdomen. The last segment is much more rounded, more prominent or exerted, more convex, and free from the rest of the body than usual, even in *Sphex*.

On a part of the head, and on the sides, and vertex, and on the tergum are blackish pigment cells; the thickened tergal portion not ending in spinules as usual. The spiracles are large and more distinct than usual in non-parasitic Apid larvæ.

In all respects the larva of this parasitic genus is lower, more degraded, much less differentiated than in the non-parasitic Apid larvæ; the lateral region is less marked; the tuberculous thickenings nearly obsolete, and the whole body more attenuated, tapering rapidly towards the head and end of the abdomen, and is more cylindrical. The head is rather smaller in proportion than in the non-parasitic Apid larvæ. The very hard chitinous mandibles; the almost obsolete maxillæ, the thickened, rounded, entire labrum, with its 4 tubercles, the minute, faintly marked clypeus, the convex surface of the epicranium, not mesially depressed, with a subtriangular depression such as usually occur in non-parasitic larvæ of this family, are signs of degeneration, or at least of adaptation to its parasitic habits, and slightly reminds us of the head of dipterous larvæ. The absence of spinules on the surface of the tergum is noticeable.

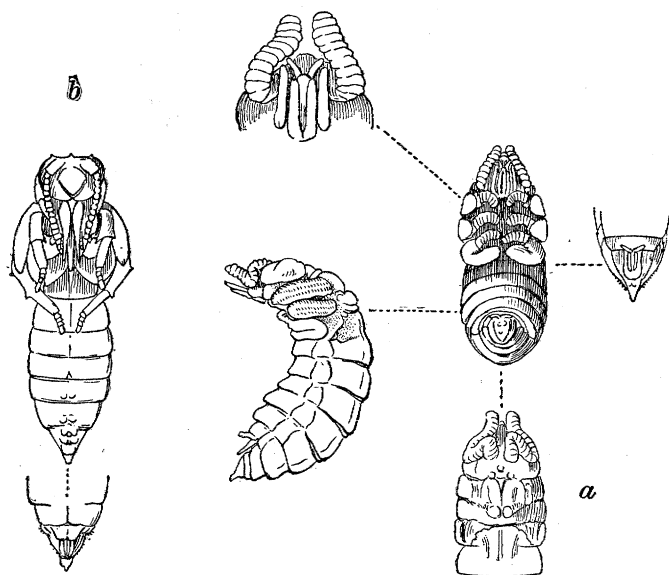


Fig. 8. *Nomada* probably *imbricata*, *a*, semipupa; *b*, pupa. $\times 3$. (Emerton del.)

***Nomada imbricata* Smith.**

Pupa.—The pupæ of both sexes occurred in the nests of *Andrena vicina*.

♂. Head not so broad as in *Andrena*. Ocelli situated in a curved raised line; on the upper and posterior edge of the orbit are three conspicuous spines, which are not present in the other genera, and are evidently of use in locomotion. Front of the head much narrower and depressed next to the orbits; the insertions of the antennæ are nearer together than in *Andrena*. Supraclypeal piece well marked, though the outlines are as yet indistinct. The clypeus is broad, subtriangular, the surface very convex. Labrum not distinct, separated by suture from the clypeus, somewhat triangular in form, with the front edge well rounded. Mandibles long, cylindrical, regularly incurved; tips unidentate, subacute. Antennæ stout, not clavate, reaching to the insertion of the posterior trochanter, also reaching just to the tips of the maxillary palpi; the joints as long as broad, each with a mesial constriction. From the labrum drops down a long slender pointed tongue-like piece (the epipharynx) into the base of the maxillæ (also present in the pupa of *Bombus*). The lingua reaches beyond the tip of the antennæ; the tip long, slender and pointed. Paraglossæ as long as the part of the

tip of the lingua extending beyond the end of the maxillæ. The 5-jointed labial palpi reach one-half way between the end of the lingua and the end of the maxillæ; the joints of both pairs of palpi rapidly decreasing in size; the maxillary palpi 6-jointed, reaching only to the tip of the maxillæ, thus being much shorter than the labial palpi, whereas in the pupa of *Andrena* they reach to and are parallel with the tips of the other pair. All the mouth parts are twice as long as in *Andrena*, and in this respect *Nomada* seems more allied to *Bombus*, etc., but otherwise, and in its elongated body especially, it is much lower. The legs are slenderer than usual, the tarsi folded on the breast as usual, the hind legs only reaching to the middle of the abdomen, which is unusually long and slender, the segments long, very convex, the sutures large, broad, deeply impressed, the hind edges much thickened, dentate beneath (not so in *Andrena*) showing that the pupa of this parasitic form probably moves about a good deal in its cell. On the hind edge of the 7th and 8th abdominal segments grow out a pair of tubercles, those on the 7th small and simple, the 2d pair (on 8th) very much larger and ending in a nipple-like papilla. The 9th sternite is square and slightly excavated at the edge, while the terminal (probably 10th) tergite is elongated into an acute extensible point tipped with black. These rhabdites agree well in form and position with those of ♂ *Andrena vicina*; they are, however, a little longer, more exserted, and the 10th tergite is longer, slenderer and more pointed.

Thorax: The mesial groove and parapsidal grooves of the mesothorax are deep and better marked than usual. The scutellum rises into two prominent tubercles which are larger than in *Andrena*, while the meta-scutellum is smaller, being small and scarcely tuberculated. The propodium is broad and flattened, contracting somewhat posteriorly. The hind tarsi are spinulated on the outer edge.

♀ differs from ♂ in the head being a little wider and the body thicker; the antennæ are of the length and size in both sexes, though differing in the adult, and the mouth-parts are precisely the same. Tip of the abdomen: ovipositor with three pairs of rhabdites almost entirely exserted; the tip is precisely as described in the ♂, ending in an acute prolonged point, and the square end of the 9th urite forming the under side of the anus is the same as in the ♀. (This identity in the pupa is interesting. The ♂ and ♀ external genitals seem to be strictly homologous in position though the genitals of the ♂ only consist of two pairs of appendages (rhabdites) arising from the 8th segment. The ♂ has one abnormal segment more, this being absorbed in the ♀. In the

abdominal ♂ tip of *Andrena* the 7th urite is rounded, triangular, covering in the two small rhabdites on the 7th segment; those on the 8th are large, smooth, full, simple, not ending in apapilla, as in *Nomada*; the 9th urite is full, not so flat and excavated or as deep as in *Nomada*; the 10th tergite rounder and shorter than in *Nomada*.

LIST OF DRAGONFLIES TAKEN NEAR BUFFALO, N. Y.

BY E. P. VAN DUZEE.

During the seasons of 1895 and 1896 I took up the collection of the local Neuropteroid insects as a recreation from the heavier work I had been doing on the Hemiptera. The time at my disposal was very limited, only a few half-days during the summer, therefore it is not likely that this list, which enumerates 41 species, is anything like a fair representation of our local Odonat fauna.

The principal localities mentioned are the following: Squaw Island and Black Rock Harbor, in Niagara River, are within the limits of Buffalo City. Ridgeway, Ont., is on the north shore of Lake Erie, twelve miles west of Buffalo, and Point Abino is just beyond. Between these stations is a large swamp separated from the lakes by sand-dunes, reaching in places a height of 100 feet. About here is by far the best collecting grounds within many miles of Buffalo. Stations at Tonawanda and Amherst are on a deep stagnant creek which affords excellent breeding grounds for many of the Dragonflies. Colden and Boston are 20 miles southeast from Buffalo, among hills about 600 feet in height, where the country is well wooded in places, and traversed by rapid streams. Lancaster, Elma and Hamburg are on the level country, about 10 miles east and south from Buffalo. Clarence is farther east, and there and at Hamburg are bog swamps that harbor many Odonata and other insects both interesting and distressing.

Several interesting localities not far from Buffalo have not yet been visited for the Odonata. Among these is Niagara Falls, and it is not improbable that this and other places at Chippewa, the lower end of Grand Island, etc., will yield numbers of fine species not on this list. Two or three species from the upper end of Grand Island taken by Mr. Philip Fischer have been included to make this list more complete.

For the determination of these Dragonflies I am indebted to the kind-